Sizing and control of a Hybrid hydro-battery-flywheel storage system for frequency regulation services.

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Abstract

Non-dispatchable RESs as wind and solar PV are characterized by high variability and unpredictability in power generation, resulting in more frequent and more intense power imbalances – hence grid frequency deviations – which, in extreme cases, could lead to catastrophic consequences. From this, higher shares of RESs generation will imply higher needs for ancillary services, the range of services that are necessary to maintain the stability and security of the electric system, such as primary and secondary regulations, involving active power dispatch. An effective way to cope with high RES variability is to absorb excess power generation with storage system and release it at times of reduced power generation. Among the energy storage technologies, pumped storage hydropower (PSHP) is one of the most mature, offering the possibility of storing energy at a very low cost compared to other technologies. However, in addition to the need for considerable investments and suitable locations, PSHP suffers from some performance limitations with respect to other storage systems. The research project aimed at assessing the benefits of hybridization of a variable-speed reversible seawater PSHP with battery energy storage systems and/or flywheel storage systems. First, a plant model was performed and simulations showed the contribution of the hybridization to the equipment in terms of reduced degradation. Then a techno-economic optimization approach was proposed to properly size and tune the hybrid system in a defined scenario.